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ABSTRACT

Problem solving flexibility (PSF), an ability commonly assessed in creativity batteries, was studied in a sample of middle class children (grades 1 through 3, average IQ 114), tested on questions resembling Guilford's consequences procedure. An hypothesis linking PSF with alertness to and interest in the environment was generally supported, more strongly for boys than for girls. Children high cn PSF had better recall for novel information and were rated higher on curiosity by their teachers. Boys who were high on PSF show what Neumann and Helson have called a patriarchal pattern of intrusive, active, assertive personality characteristics. The pattern for girls was somewhat more subdued, but still suggested responsiveness to novelty and diversity of experience. PSF was associated positively but weakly with IQ, was negligibly related to test anxiety, and was positively correlated with school achievement. The relations of creativity to cognitive, personality, and motivational variables were also surveyed. (Author/JD)

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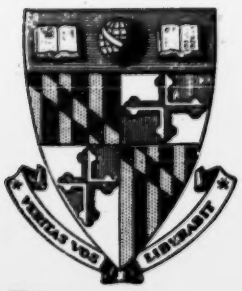

THE JOHNS HOPKINS UNIVERSITY REPORT No. 58

THE CENTER FOR THE STUDY OF SOCIAL ORGANIZATION OF SCHOOLS

CORRELATES OF PROBLEM SOLVING FLEXIBILITY

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Preface

Center Program III concerns itself with the socialization of cognitive and academic skills. This report is one of a series dealing with the development of and interrelations among cognitive and academic achievement variables in middle class youngsters in grades one through three. Other reports in the series so far are Center Reports No. 32 (Robert Hogan and Ellen Greenberger, "Development of a Curiosity Scale") and No. 56 (Ellen Greenberger, "The Development of New Measures of Curiosity for Children").

Abstract

This report reviews briefly the relations of creativity to cognitive, personality, and motivational variables and describes a study based on one ability commonly assessed in creativity batteries: problem-solving flexibility (PSF). A sample of middle-class children in grades 1 through 3 was tested on questions resembling Guilford's "consequences" procedure. An hypothesis linking PSF with alertness to and interest in the environment was generally supported, more strongly for boys than for girls. Children high on PSF had better recall for novel information and were rated higher on curiosity by their teachers. Boys who are high on PSF show what Neumann and Helson have called a patriarchal pattern of intrusive, active, assertive personality characteristics. The pattern for girls is somewhat more subdued, but still suggests responsiveness to novelty and diversity of experience. PSF was associated positively but weakly with IQ, was negligibly related to test anxiety, and was positively correlated with school achievement.

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In this paper we explore a number of cognitive, motivational, and personality correlates of one divergent thinking ability: the ability to generate a diversity of potential solutions to novel problems. This variable is related to the concepts of spontaneous flexibility and adaptive flexibility (e.g., Guilford, 1967; Taylor & Holland, 1964; Torrance, 1962) and is discussed typically under the heading of creativity.

Recent work has raised important questions about previous research on creativity. Torrance's research, for example, has been criticized on the grounds that the individual tests comprising his creativity battery, which are scored for flexibility among other criteria, are no more highly intercorrelated than are creativity and IQ (Wallach, 1968). Such facts call into question the dimensionality of creativity and its distinctiveness from behavior assessed by intelligence tests (Wallach & Kogan, 1965). These are important issues, but not ones with which the present paper is centrally concerned. Rather, it is the purpose of this report to regard flexibility as one (among many) important cognitive skills and to present and discuss findings concerning the development and correlates of flexibility.[1]

Guilford (1967) discusses flexibility in the general context of problem solving. He regards flexibility as a factor that insures fluent information production by preventing the search for relevant

information from becoming too narrow in scope. Especially where the demand-characteristics of the task are divergent rather than convergent, flexibility --the ability to shift categories-- increases the likelihood that the would-be problem solver will come up with a usable idea.

Flexibility appears as one of several criteria of "creativity" in numerous studies: e.g., Flescher, 1963; Getzels & Jackson, 1962; Klausmeier & Wiersma, 1964; Torrance, 1962. In the few studies that deal principally with flexibility, there is an emphasis on sex differences. Klausmeier & Wiersma (1964), studying fifth and sixth grade children with IQ's over 115, found a significant sex difference favoring girls on a task calling for unusual uses of common objects. Responses were scored for flexibility--the diversity of classes of use suggested by the youngster. Girls also scored higher on several other divergent tasks, whereas boys did better on a group of convergent tasks. In another study by the same authors (1965), no sex difference was found for uses-flexibility, and the other results of the previous study also were not clearly replicated. Ss in this case were seventh grade children of low, average, and high IQ. Trembly (1964) reports that girls and women are superior to boys and men over a wide age range in their responses to a single question scored for flexibility ("What would happen if all plant life were to disappear from earth?"). Regarding divergent thinking tasks in general, Maccoby (1966) concludes that the evidence favors girls, although findings are not entirely consistent.

Typically, problem-solving flexibility has been studied in combination with other cognitive skills such as fluency and originality. Composite scores on this set of indicators are often used to rate an individual's "creativity." Among the most frequent foci of research on creativity are the personality and family-background correlates of creative persons; the relation between creativity and academic or professional achievement; and the relation between creativity, intelligence, and anxiety. We shall examine briefly the nature of the findings in these areas.

Reviewing a number of studies of personality factors, Taylor & Holland (1964) describe creative men as more autonomous than less-creative individuals, more self-reliant, more independent, more intellectually persistent, more feminine than other men in interests and characteristics (especially with respect to awareness of their own impulses), and more attracted to complexity.[2] Characteristics such as these appear with regularity in studies using different samples and different criteria of creativity. Thus, the traits cited are congruent with MacKinnon's (1965) description of "creative" architects, selected by peer nominations; Barron's (1957) "original" Air Force officers, selected by a combination of tests, interviews, behavioral observations and ratings; Parloff & Datta's (1965) study of male high school seniors, selected on the basis of science project reports submitted to a Westinghouse national talent search and subsequently scored for "potential creativity" and high rankings on a science aptitude examination; Torrance & Dauw's (1966) findings for high school seniors, both male and female, selected from a battery of divergent-thinking tests scored for originality and elaboration; and Helson's (1968a) conclusions

about Mills College women nominated by the faculty as having potential for creative work in the arts, sciences, or humanities. Studies of younger children comment especially on the playfulness of creative youngsters and their independence from the environment (Getzels & Jackson, 1962; Weisberg & Springer, 1961); and on their self-acceptance (Weisberg & Springer, 1961; Wallach and Kogan, 1965, for children high on both creativity and intelligence but [illegible] high creative-low intelligence youngsters).

Recent work by Greenberger (1969) has demonstrated an association between scores on a teacher-rated curiosity scale and problem-solving flexibility for both boys and girls in the first three grades. Curiosity has been overlooked, for the most part, in research on cognitive excellence. Two exceptions come from the research of Houston & Mednick (1963) and Maddi, Propst & Feldinger (1965). The former found that college Ss who performed well on the Remote Associates Test (RAT), in contrast to low scorers, selected more words followed by E's production of novel associates than words followed by high-frequency associates. The RAT, while a convergent task, does require adaptive flexibility for "solution" of the problems. Maddi et al. found non-significant relations between a projective measure of curiosity and uses-flexibility in a college sample. The somewhat uncertain validity of the scoring system for curiosity in combination with the problematic reliability of projective tests (Entwisle, 1970) may account for the null findings.

Certain aspects of the family background of creative individuals are frequently mentioned, as for example, MacKinnon's finding that

the family unit of creative architects was not especially close, compared with that of far less creative architects. (Weisberg & Springer, 1961, report a similar pattern among fourth-grade children). MacKinnon (1965) suggests that the absence of strong emotional ties, in the context of disciplinary consistency and clarity of standards, may have a liberating effect on a child's development. Among the less-known findings are ones which concern the association of creativity and birth order.

Both Helson (1968a) and Weisberg & Springer (1961) suggest that sibling position may be related to creativity. Influenced by Rank, Helson suggests that the first-born child experiences an estrangement from his parents and a loss of adaptation when a sibling is born. The first-born is pre-disposed to eminence, including the possibility of attaining eminence through creative achievements, by virtue of the need to regain his original favorable position or to integrate troubling experiences. Helson's study of Mills College alumnae and their siblings shows that most of the creative women were first or second children, who more often reported experiencing deprivation in affection or attention due to competition with siblings than the less creative women. Weisberg & Springer (1961) report that there was a predominance of first-borns in their study of creative fourth-grade children. Because both studies were based on small n's, the findings would be strengthened by replication.

Recent work suggests that the adult eminence of first-born children --the educational attainment of whom has been reviewed by Altus (1966)-- may in fact depend also on sex of the siblings.

Smelser and Stewart (1968) studied the educational achievement of white middle-class individuals from two-child families. In all-male and all-female sib-sets, there was no consistent difference in educational achievement favoring the older child. However, in mixed sex sib-sets, there is a marked tendency for the first-born child to attend and graduate from college and to go to graduate school more often than his or her younger sibling. Furthermore, it appears that the boy from a girl-boy constellation has lower educational attainment than the younger boy with a male older sibling. The psycho-social mechanisms underlying these relationships need further explication.

Brim (1956) found substantial personality differences in five and six-year old children with a same versus opposite-sex sibling (all children came from two-child families). Girls, especially when the younger child, had more "masculine" traits if they had a brother rather than a sister. They did not, as a consequence, score lower on feminine traits, but appeared to have a more complex behavioral repertoire. The findings for boys show that those with an older sister are markedly more feminine than those with an older brother. The results are less striking for elder boys with a younger sister. Boys with an older sister score lower on masculine traits than boys with an older brother. Examples of male and female traits in this study are aggressive, curious, original, self-confident, on the one hand, and affectionate, cheerful, friendly, and kind, on the other. Brim accounts for the tendency of younger children to acquire the sex-typed

characteristics of an older cross-sex sibling in terms of role assimilation and the power of the elder child. It would be interesting to know if children occupying different sibset positions vary in cognitive characteristics as well as in personality traits. The only cognitive characteristics, however, which have been examined in relation to sibset variables are intelligence and aptitude (Koch, 1954; Rosenberg & Sutton-Smith, 1969). Helson's (1968b) view that creative persons are better able to integrate in themselves the characteristics of the opposite sex suggests that creativity and problem-solving flexibility may be found more often in (a) girls with brothers (especially, in line with Brim's findings, <u>older</u> brothers); and (b) in boys with sisters (perhaps, following Brim, <u>younger</u> sisters, who are less disruptive of a boy's masculinity, while still associated with an increase in the brother's femininity).[3] In Helson's (1968a) study of Mills College women it appears that creative women tended to have a brother as the next-oldest or next-youngest sib, more often than a sister.

There is a substantial body of research on the relations between creativity and global measures of intelligence (Torrance, 1962; Wallach & Kogan, 1965). The interpretation of findings is complex. While some investigators proclaim the relative independence of creativity and intelligence (e.g., Torrance, 1962), others reviewing the same body of literature come to quite opposite conclusions (Wallach & Kogan, 1965). It appears that low correlations between creativity and intelligence are most likely to be found in studies of gifted people, due in part to

the restriction in score ranges; in studies where the creativity scores are unreliable, due to low intercorrelations among the individual creativity "tests" (e.g., Getzels & Jackson, 1962); and in studies where the creativity variables and the manner of their assessment were selected explicity to minimize the overlap with what intelligence tests measure (e.g., Wallach & Kogan [1965] in their emphasis on fluency and originality measured without time constraints or other sources of achievement pressure). In a study of seventh graders, however, Uses-flexibility increased steadily from low to average to high IQ groups (Klausmeier and Wiersima, 1965).

Little research has been carried out on creativity (or specific aspects of creativity such as flexibility) and separate aspects of intelligence. Creative (original, fluent, or varied) ways of carrying out tasks can be seen as a particular style of problem solving. Guilford (1967) and Newell, Shaw & Simon (1958) have proposed an important connection between the ability to solve problems and memory. For example, Guilford, outlining a "transfer" theory of productive thinking, states that the way in which a problem is structured by (or for) an individual sets up a search for models which in turn operate as cues for the retrieval of stored information. The production of problem-relevant ideas occurs through transfer or generalization: cues that had not been present in the original learning situation get associated with stored information. Flexibility is a cognitive style which insures much rather than little transfer and,

once information is recovered from memory, facilitates the transformation or reworking of information for new uses and new connections. It is clear that Guilford regards previous learning, good retention, and flexible strategies for information retrieval as important components of problem solving. The study of creativity and memory is, however, virtually unexplored territory.[4]

Generally, researchers have found significant associations between creativity and academic achievement. In some cases, however, the high zero-order correlations are due chiefly to the correlation of creativity scores with intelligence test scores. Wallach (1968), reviewing a study presented in Torrance's Technical Manual, points out that while eight of twelve correlations between Torrance variables and academic achievement indices were .2 or higher, only three of the twelve correlations remained at this level when IQ was partialled out. In a similar vein, he comments on a study by Bowers (1966), where zero-order correlations of intelligence with achievement indices were about .7, and addition of creativity scores to intelligence scores increased the predictability of achievement from intelligence alone by only very little (a few hundreths of a point for the multiple correlation).

Maccoby (1966), reviewing a large number of studies of anxiety and performance, concludes that anxiety plays a different role for the two sexes and that its role may be different at different ages. In relation to measures of aptitude or achievement, correlations with anxiety are usually substantially negative for girls and women,

but low negative, zero, or positive for boys and men. Flescher (1963) found no significant relationship between General or Test Anxiety and either IQ or creativity in a sample of sixth grade youngsters. Wallach & Kogan (1965) found no significant effects of anxiety on creativity for either sex. Other findings they present suggest that the way in which emotional disturbance is handled, rather than the existence of disturbance, may affect creative behavior. Among boys, scores on defensiveness were inversely related to scores on creativity. This finding is consistent with other researchers' observations on the relative absence of repressions among older "creative" Ss.

In the present study we shall explore the relationship of problem-solving flexibility to personality and family characteristics, cognitive characteristics, academic performance, and test anxiety. It seems reasonable to suppose that individuals who are able to draw ideas from different categories of experience and solve problems "flexibly" may be curious individuals who seek out and store novel stimulation. Accordingly, we will test the hypothesis that problem-solving flexibility is associated with a high level of alertness to and interest in the environment, as measured by teacher- and self-ratings of curiosity, ability to detect verbal absurdities, and recall of novel experience. It is also predicted, given a sample of children with above-average IQ's, that intelligence and test anxiety will have only small correlations with problem-solving flexibility. We predict, finally, higher problem-solving flexibility scores for children with opposite-sex siblings than for those with

only same-sex siblings, although the basis for this prediction is very weak.

METHOD

Ss were children selected randomly from grades 1, 2, and 3 of a white middle-class suburban school. As part of a larger study (Greenberger, 1969) data were gathered from school records on IQ, sex and age of siblings, and average grade obtained in the marking period immediately subsequent to the testing and rating of youngsters. Average CTMM IQ for the 113 Ss on whom such data were available was 114.2, with virtually no difference between boys and girls.

Intact classes were administered the Sarason et al. (1960) Test Anxiety Scale for Children under group-testing conditions. The recall task involved tape-recorded presentation to whole classrooms of two stories, each containing a great deal of novel information (as why popcorn pops and how an elephant may be taught to eat disliked foods by manipulating hunger drive and furnishing additional rewards).[5] Ss in the sample were tested individually one week later for recall. The self-report procedure for assessing curiosity is a revision of a procedure devised by Maw & Maw (1965)[6]. Our revision, hereafter called the Investigatory Activities Inventory (IAI), consists of 19 items with three alternatives each. The items are read aloud by the examiner, while each S follows along on his copy of the inventory.

The alternatives are accompanied by drawings to help young children with varied reading skills to read and remember. A sample item is, "If you heard there were going to be falling stars in the sky at eleven o'clock in the evening, would you (a) ask your parents about it the next morning, (b) try to stay awake to see it for yourself, or (c) try to forget it and get your sleep?" The choice of the most actively investigative response, (b), indicated by the child's circling that picture, is scored one point; choice of the alternatives is scored zero. "Foolish Sayings" was adapted from a longer and more difficult scale developed by Maw & Maw (1964-65). Children, tested in intact classrooms, listened to a series of 15 statements, 9 of which were "absurd," 6 of which made sense. They circled yes or no on an answer sheet in response to the question, "Was that foolish?" A sample item is: "No child wanted to be last in line, so the teacher let the last child come up and walk with her."

Teachers used two instruments to make ratings of children's curiosity: an Adjective Checklist which yields scores both on curiosity and halo characteristics (Hogan & Greenberger, 1969); and a Behavior Profile with subscales for curiosity, achievement strivings, and achievement blocks (Greenberger, 1969). Briefly, the Checklist curiosity score contains 20 curiosity "positive" adjectives such as active, daring, and resourceful from which are subtracted the number of adjectives (out of 10) judged to be contra-indicative of curiosity. Examples are meek, fearful, withdrawn. Halo scale adjectives include,

among others, considerate, cooperative, friendly. The Behavior Profile consists of the three subscales noted above and 8 "filler items" which do not belong to any of the subscales. Sample items are, tries to figure things out and actually experiments, tries things out. The Behavior Profile Curiosity scale (BPC) is based on a problem-finding, problem-solving conceptualization of curiosity.

As part of a study of curiosity (Greenberger, 1969), children were asked, "Which parent best likes to answer your questions?" This question was put immediately after Ss had viewed incongruous pictures and had had the opportunity to obtain information about these pictures. Data on this question will be included in our discussion of family variables associated with problem-solving flexibility.

Problem-solving flexibility was assessed in individual testing sessions with a female examiner. The directions for the task and the seven problems were:

> We are interested in finding out what children your age think about things. I will read some things to you for you to think about.
>
> For instance, suppose you saw a man walking on his hands. Why do you think he might be doing that? What you should do is tell me as many different reasons as you can think of. When you feel you have finished answering, let me know, so that I will know when to go on to the next question.
>
> 1. Suppose someone left the class and when he returned told you the sidewalk outside was wet. How could it have gotten wet?
> 2. Suppose one day when you came to school, your best friend was not there. What do you think could have happened?

3. What would things be like if people could fly?
4. What would happen if it was always summertime?
5. What would things be like if people no longer needed or wanted sleep?
6. What would things be like if none of us needed food anymore in order to live?
7. What would happen if everyone in the world suddenly forgot how to read and write?

These items are similar or identical to those used previously by Guilford et al. (1957).

Scoring reflects the number of different categories into which a S's responses fell. For example, a child who answered the first question, "It might have rained. Or someone could have been watering the lawn. Or maybe a water pipe broke underground. Maybe someone spat there. Maybe they were putting down new cement." got a higher score than a child who replied, "Maybe a water pipe broke underground. Maybe someone was carrying a pail with a hole in it. Maybe someone dropped a drink there. It could have been a bottle of milk that broke." The second child's answers all fit the category "accidental event," whereas those of the first child include not only this category, but intentionality and an event of nature.

Es recorded Ss' answers on a mimeographed form listing the most likely categories of responses, as determined by a pilot study. When any doubts arose, the child's verbatim answer was recorded. An unforeseen consequence of this otherwise-useful procedure was the impossibility of scoring protocols for related variables of interest such as originality or fluency because when an answer fell into a category

already "used," the answer was not recorded.

Protocols were scored by two persons independently; their scores correlated .90.

Table 1 shows the number and grade-sex distribution of children in the study.[7]

TABLE 1 ABOUT HERE

RESULTS

1. Reliability

The internal consistency of the problem-solving measure was evaluated by a procedure similar to Hoyt's (1941) procedure and recommended by Julian Stanley to accomodate statistics already computed.[8] The average intercorrelation of scores for the seven "problems" was .42 for boys and .45 for girls. Reliabilities, in the same order, were .84 and .85. Looked at grade by grade, the average intercorrelations for first, second, and third graders, in that order, are .42, .31, and .46, with associated reliabilities of .84, .76, and .86. The peculiar dip noted in the second grade is not easily accounted for, but may be simply a chance fluctuation.

2. Relation of problem-solving flexibility to other variables

Table 2 displays the correlations of other cognitive, motivational, and school-achievement variables with problem-solving flexibility. Overall, the pattern and degree of association is very similar for boys and girls with two exceptions, which will be noted later.

TABLE 2 ABOUT HERE

The hypothesis that problem-solving flexibility is associated with alertness to and interest in the environment is strongly supported for boys and moderately well supported for girls. For boys scores on Recall, Foolish Sayings, Investigatory Activities Inventory, Behavior Profile Curiosity, and Checklist Curiosity are positively related to performance on the problem-solving task. For girls, Checklist Curiosity and Investigatory Activities are not related to problem-solving flexibility, but the other three variables are. For both sexes the variable most strongly associated with problem-solving flexibility is Recall.

In order to obtain a clearer picture of the personality-cognitive characteristics of children who vary in problem-solving flexibility, each item on the Behavior Profile and Adjective Checklist was examined in relation to problem-solving flexibility, with the effect of IQ

partialled out. (As shown in Table 2 and discussed shortly, IQ has a small but significant association with problem-solving flexibility.) Of the fourteen Behavior Profile Curiosity items, thirteen have significant partial correlations with boys' problem-solving flexibility, and nine with girls' problem-solving flexibility. These items (and those approaching the 5% level of significance) are identified in Table 3.

TABLES 3 AND 4 ABOUT HERE

For boys five, and for girls three, of eight items on the Behavior Profile Achievement Strivings subscale are related to problem-solving flexibility. (For both sexes the zero-order correlation of the achievement scale is significantly related to problem-solving flexibility.) For each sex, one of the three Blocks items is associated with problem-solving flexibility, and the Blocks scale as a whole is significantly correlated with PSF. Nearly half of the curiosity-positive adjectives on the Adjective Checklist have significant correlations with problem-solving flexibility for boys, whereas none do for girls.

Among the most highly associated Behavior Profile Curiosity items for boys are those that have the clearest problem-solving content: <u>likes to solve problems</u> and <u>tries to figure out explanations for</u>

things. The strongest items for girls have a somewhat more diffuse, less active tone, calling to mind Neumann's (1964) and Helson's (1968b) discussion of patriarchal versus matriarchal types of creativity. It is interesting, in this connection, to examine the traits from the Adjective Checklist that relate to problem-solving flexibility. It is apparent from Table 4 that the boys' picture includes more active, intrusive, "patriarchal" qualities than the girls'.

Turning back to Table 3 and the Behavior Profile Achievement Strivings items, it seems that the achievement strivings which relate to problem-solving flexibility are quite similar for the two sexes, with possibly more competitiveness and emotional involvement in achievement on the part of boys, more compliance with social expectations for good performance on the part of girls. The latter interpretation gains a bit of support from the appearance of resourceful, considerate, cooperative (Table 4) and likes spelling drill and (nearly significant) likes to help teacher (Table 3) as correlates of problem-solving flexibility in girls. The existence of sex differences of this kind underlying the motivation to achieve has been documented by many researchers, among them Sears (1962) and Crandall (1963).

The openness of flexible problem-solvers to novel and varied experience is nicely suggested by the relatively high correlation of interested in people who are different from self with problem-solving flexibility (filler item, Table 3).

The search for family characteristics associated with problem-solving flexibility does not yield many significant findings. Boys' and girls' replies to the question, Which parent best likes to answer your questions?, were examined separately in one-way analyses of variance. For boys, naming the father was associated with significantly higher scores on problem-solving flexibility ($F=4.74$, df 72, $< .05$ $p >.01$). For girls, the parent selected was unrelated to problem-solving flexibility ($F=.07$, NS). The finding for boys is consistent with the "patriarchal" traits observed in boys who score high on PSF.

Problem-solving flexibility was also examined in relation to one- versus mixed-sex sibsets and to other sibling and birth-order variables. Separate one-way analyses of variance for boys and for girls showed that the sex composition of S's sibset (all same-sex versus mixed) was not significantly associated with problem-solving flexibility. Problem-solving flexibility also was not related to birth order (first versus later born) or to sex of the next-oldest sibling. (Brim, 1956, it will be recalled, found personality differences between children with older siblings of same versus opposite sex.) However, boys who have as a next-younger sibling a sister rather than a brother obtain higher problem-solving scores ($F=4.70$, df 51, $.05>p<.01$). For girls there is a nonsignificant tendency for girls with a next oldest male sibling to score higher on problem-solving flexibility ($F=3.12$, df 51, $p<.10>.05$). In other words there is a suggestion in these findings that children born in a brother-sister sequence, in families of variable

size, may have more flexible approaches to problem solving.[9] The reasons are far from clear.

We turn now to the relationships between problem-solving flexibility and IQ, test anxiety, and academic achievement.

IQ shows only a low positive relationship to problem solving for boys and girls alike. Although this finding is generally consistent with the literature on creativity and intelligence, the low relationship may be due in part to the nature of the scoring procedure, which did not take into account variations in the "quality" of the answers, except for dismissing blatantly irrelevant or absurd responses. Scores on Test Anxiety are not significantly related to performance on the problem-solving task, a finding that is generally in accord with research on creativity and anxiety. Table 2 reveals consistent relationships between problem-solving flexibility (even with IQ partialled out) and school achievement, as measured by grades for all Ss and by standardized achievement tests as well for third grade children. It seems plausible that a cognitive style characterized by the ability to structure problems in alternative ways may be involved also in performing well on school tasks. For example, it probably pays off to consider alternative possibilities, while reading, when trying to figure out a word (assuming that the guesses are systematic, rather than random). The same argument is also reasonable with respect to other areas such as social studies, but may be less defensible for subject matter such as arithmetic, given the convergent nature of most arithmetic tasks.

3. Developmental trends

Mean problem-solving scores increase with age, as would be expected.

TABLE 5 ABOUT HERE

That is, one would expect scores on a task involving a number of cognitive components and a degree of test-taking savoir faire (ability to follow directions and to function efficiently in a test-like situation with a stranger) to increase over a three-year span of development. The data suggest a greater relative increase in problem-solving flexibility between grades 1 and 2 than between grades 2 and 3. The difference between the grades 1 and 2 means is significant ($t=4.19$, $p<.001$), while the difference between grade 2 and 3 means is not ($t=1.67$, p .10). These results are in general agreement with other findings; Torrance (1962) reports that for most of the "creative thinking" abilities assessed in the Minnesota studies, there is a steady increase from first through third grade. Sex differences favor girls slightly at all grade levels, but none of the differences come close to being statistically significant (t's of 0.68, 0.53, and 0.31 for grades 1, 2, and 3 respectively).

Due to the strong association of recall with problem-solving flexibility, on which we will comment subsequently, the developmental course for this variable is of special interest. Mean differences on

recall rise steadily from grades 1 through 3. Both the difference between grade 1 and grade 2 and the difference between grade 2 and grade 3 are significant ($t=2.27$, $p = .03$; and $t=3.72$, $p<.001$). Only at first grade are the sex differences in mean score significant ($t=2.02$, $p<.05$). As was the case for problem solving, girls perform better than boys. This trend continues, but is not significant, at the two remaining grade levels ($t=0.41$, and $t=0.07$).

Scores on three other variables rise especially between grades 1 and 2. These variables are ability to detect verbal absurdities, investigatory activities, and test anxiety. It appears that this is an interval of marked growth in children's cognitive efforts and abilities and of considerable fear of failure, perhaps due to unclarity about the level of their skills. While girls tend to have an advantage over boys on several cognitive skills at grade 1 (not, however, more than a trend in some cases), by the end of grade 3 boys have caught up and in some cases begun to surpass girls.

DISCUSSION

Problem-solving flexibility is of especial interest in this era in view of the rapidly changing nature of the environment and the demands upon individuals to find ways of coping with novel events. The findings in this sample of children of above-average intelligence suggest that variations in personality and cognitive characteristics are at least as important, and perhaps more important, than IQ in

accounting for differences in PSF.

Despite the low observed correlations among creativity measures, certain of the personality characteristics of children high on PSF turn up regularly in studies of creativity, regardless of the age level of the Ss. The similarities among findings are greatest for boys. To cite a number of examples: MacKinnon's highly creative (male) architects, in comparison with less creative ones, more often describe themselves as inventive, determined, independent, individualistic, and enthusiastic --all part of the Checklist Curiosity scale that, for boys, is positively correlated with problem solving. Two of these adjectives (and one for girls), taken individually, related significantly to problem-solving scores. Barron (1957) in the study cited earlier compared Q-sort and Adjective Checklist descriptions of male Air Force officers rated high and low on originality. Some of the adjectives differentiating these groups at the five per cent level or better were: interests wide, clever, imaginative, determined, resourceful, talkative, efficient, initiative, enterprising, and energetic. Lows were, among other things, more often dull, simple, and apathetic. The latter group of adjectives are all part of the Checklist Curiosity negative subscale, while several of the former are part of the Curiosity positive scale; several of these descriptors taken individually are significantly correlated with boys' flexibility scores.

Some of Barron's other findings also suggest links with our results for both sexes. The original men's "disposition towards

integration of diverse stimuli" (number of Rorschach Whole responses, number of different determinants used, idea classification test) suggest, he feels, "openness to a variety of phenomena" (viz. Behavior Profile Curiosity item, wonders about, becomes fascinated by, a variety of things), combined with a strong need to organize these phenomena into some coherent pattern (viz. Behavior Profile Curiosity items, tries to figure things out, likes to solve problems; and for girls only, will work hard to find the answer to a problem). The overall description of original men as highly cathecting intellectual activity seems consistent with the strong relationship of BPC to problem-solving flexibility in both sexes. In another study, Barron (1963) suggests that creative individuals are more observant and value accurate observation (viz. Behavior Profile Curiosity item, examines, notices carefully).

The fit with previous research answers the question, "What's old (and familiar)?" What is new in this study is the evidence that youngsters who can come up with reasonable explanations or solutions to novel problems are youngsters who show an observable predilection for experiencing novelty. Although the creativity literature contains occasional references to curiosity or openness to experience, the evidence is often retrospective or indirect, as in the case of inferences from projective-test responses. On the grounds of several direct or non-projective procedures used in this study to assess current behavior --recall, Foolish Sayings (detection of verbal absurdities), curiosity ratings-- it appears that children who are flexible problem solvers are

open to and curious about the environment. The most novel finding concerns the strong relationship between recall and PSF, where the recall procedure taps mainly memory for new information (e.g., how heat causes "popcorn" to pop by converting the moisture in the kernel to steam).[10] The memory variable has received little systematic attention in studies of creative behavior. More refined studies of different types of memory (meaningful versus nonsense material, memory span, novel versus routine content, etc.) seem well worth while.

We have put forth the argument that those who like to experience diversity and novelty are more likely to produce diverse solutions to novel problems. Some of the evidence used to support this argument lends itself to other interpretations. For example, it could be argued that the relationship between PSF and Foolish Sayings is due to common elements in the two tasks. Foolish Sayings consists of problems, just as PSF does, and detecting the absurdities in the Foolish Sayings procedure is not altogether unrelated to detecting the essence of the problem in PSF. Other evidence, however, in the form of curiosity ratings and recall of novel material, seems to support the paper's argument.

The findings for the present age group on PSF do not support MacKinnon's (1965), Barron's (1957), and Helson's (1968b) theories and findings on the more available bisexuality of creative persons, compared with individuals who are less creative. The boys in the study display a quite intrusive, "patriarchal" pattern, with the caveat that they allow themselves some "spread" (of interests) and openness to uncer-

tainty. It is interesting, in this connection, that boys high on PSF report that their father is the parent who relates to them over questions and question-asking. The girls who are flexible problem-solvers appear somewhat compliant and socially pleasant but also have more individuality, resourcefulness, and ease and pleasure in the face of novelty, surprise, and problems-to-be-solved than other girls. Overall, our picture of the boy who scores high on PSF is clearer than that of the high PSF girl.

Footnotes

[1]We are grateful to Julian Stanley for his knowledgeable comments on and criticism of the paper.

[2]Helson suggests that creative women, while "matriarchal" in their style of thinking, may be more masculine than other women in their need for autonomous self-expression. The term matriarchal in this connection is from Neumann (1954), who speaks of two types of consciousness: patriarchal (purposeful, assertive, objective) and matriarchal (brooding, reflective). Neumann claims that in the creative person one of these patterns may predominate, but there is access to both styles of thought.

[3]A number of studies suggest that the strength of male characteristics in both sexes is associated with problem-solving skill. This was in fact the case in Milton's research on college students, for both convergent problems and those requiring restructuring (adaptive flexibility).

[4]A somewhat specialized type of memory has been commented on by Barron (1963) and Weisberg & Springer (1961), among others. They report that creative individuals exhibit less repression of painful personal feelings and experiences than individuals who are less creative.

[5]The presentation was made under relaxed conditions with no mention of a future assessment of learning. Children were told to listen carefully and see what they could learn from the stories they were about to hear. The stories were played in the classroom, without the teacher's presence, in a session marked by laughter and occasional talking among children.

[6]We are indebted to Wallace Maw for providing us with the longer form of this scale, originally used with fifth-grade children. Our revisions included shortening the scale; reducing the number and in some cases altering the wording of alternatives; and adding pictures, which were drawn by Amy Schewel.

[7]This table takes as its basis the sample of children on whom problem-solving data were obtained. As part of a larger study (Greenberger, 1969), additional numbers of Ss were actually tested on many of the other variables.

[8]The reliability coefficient is approximately $\frac{I(\bar{r})}{1+(I-1)(\bar{r})}$, where I is the number of items, and $\bar{r}$ the average intercorrelation of the items. This formula is especially useful when r is already available.

[9]The majority of work on sex of the sibset focuses on the "pure" case of the two-child family (with its eight possible sex and birth order positions). Analysis of two-child families only was not practical in a small sample such as ours.

[10]We assumed that children this age had little prior exposure to information of this kind. In the future, however, it is essential to obtain more objective measures of informational novelty.

Table 1. Number of subjects, by sex and grade level, assessed on each variable

Variables	Grade 1		Grade 2		Grade 3		Totals		
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	All Ss
Problem solving	27	21	29	29	29	26	85	76	161
IQ	--	--	29	29	29	26	58	55	113
Test Anxiety	25	20	26	27	25	22	76	69	145
Adjective Checklist	15	11	29	29	12	9	56	49	105
Behavior Profile	15	11	29	29	12	9	56	49	105
Recall	26	19	24	27	27	24	77	70	147
Investigatory Activities	27	21	27	27	26	22	80	70	150
Foolish Sayings	25	20	29	29	26	26	78	69	147
Average Grade	27	21	29	29	29	26	85	76	161
Reading Grade	--	--	29	29	29	26	68	55	113
Arithmetic Grade	27	21	29	29	29	26	85	76	161
Social Studies Grade	27	21	29	29	29	26	85	76	161
Iowa Achive-ment	--	--	--	--	28	25	28	25	53

Table 2. Correlation of cognitive, motivational, and academic achievement variables with problem-solving flexibility

	Boys		Girls		All Subjects	
	Zero-order correlations	Partial correlations (IQ removed)	Zero-order correlations	Partial correlations (IQ removed)	Zero-order correlations	Partial correlations (IQ removed)
IQ	.23*	--	.23*	--	.23**	--
Test Anxiety	-.06	-.01	-.17	-.09	-.12	-.06
Behavior Profile Curiosity	.41**	.36**	.37**	.33**	.38***	.33***
Checklist Curiosity	.44***	.39**	.09	.05	.22**	.17*
Recall	.57***	.53***	.56***	.56***	.56***	.54***
Investigatory Activities	.28**	.27**	.00	.06	.13	.14
Foolish Sayings	.31**	.31**	.34**	.30**	.32***	.31***
Average Grade	.32**	.25*	.32**	.26*	.32***	.26**
Reading Grade	.39**	.34**	.32**	.28*	.35***	.31**
Arithmetic Grade	.16	.08	.26**	.19	.21**	.13
Social Studies Grade	.33***	.26**	.27**	.23*	.31***	.25**
Iowa: Vocabulary	.35*	.30	.46**	.41*	.41**	.36**
Iowa: Reading	.43*	.38*	.51**	.46**	.47***	.42**
Iowa: Arithmetic	.29	.23	.36*	.30	.32**	.26*

*$p < .05$
**$p < .01$
***$p < .001$

Table 3. Partial correlations (IQ removed) of Behavior Profile items with problem-solving flexibility

Curiosity items	Boys (n=56)	Girls (n=49)
Loves to learn new things	.41**	.26*
Likes to solve problems	.37**	.22+
Tries to figure things out	.31*	NS
Experiments, tries things out	.30*	.21+
Interrupts with questions	.28*	.24*
Tries to touch the new	.26*	.33**
Examines, notices carefully	.26*	.27*
Wonders about a variety of things	.26*	.27*
Prefers new stories to old	.26*	.20+
Gets excited about the unexpected	.24*	.32*
Likes expectations disconfirmed	.24*	.26*
Has a long term interest	.23*	.29*
Raises questions	.23*	.34**
Will work hard to find answer to a problem	NS	.20+

Achievement strivings items	Boys (n=56)	Girls (n=49)
Spontaneously tries again after failing	.37**	.28*
Wants to do better than others	.30*	.30*
Feels pleasure after doing well	.29*	NS
Strong need to do well	.27*	.18+
Feels bad when does poorly	.24*	.22+
Practices, drills, studies	NS	.23*
Blocks items		
Expects to do poorly	-.32**	NS
Accidents, forgetting, interfere with achievement	NS	-.24*
Filler items		
Interested in people who are different from self	.38**	.29*
Tries to do well because likes feeling competent	.21+	.23*
Likes spelling drill	NS	.26*
Likes to help teacher	NS	.21+

+ $.05 < p < .10$
* $p < .05$
** $p < .01$
*** $p < .001$

Table 4. Partial correlations (IQ removed) of Checklist adjectives with problem-solving flexibility

Boys (n=56)		Girls (n=49)	
Curiosity positive		**Curiosity positive**	
Independent	.41**	Individualistic	.21+
Talkative	.36**	Resourceful	.21+
Assertive	.34**		
Adventurous	.30*	**Curiosity negative**	
Interests wide	.30*	meek	-.22+
Curious	.29*		
Individualistic	.25*	**Halo**	
Aggressive	.22+	Cooperative	.27*
Resourceful	.22+	Considerate	.24*
Daring	.20+		
Curiosity negative			
shy	-.34**		
quiet	-.22+		
Halo			
--			

\+ $.05 < p < .10$

* $p < .05$

** $p < .01$

*** $p < .001$

Table 5. Performance on problem solving and recall tasks by grade and sex

	Boys		Girls		All Ss	
	Problem Solving	Recall	Problem Solving	Recall	Problem Solving	Recall
Grade 1						
Mean	6.22	9.79	7.30	14.00	6.56	11.54
S.D.	3.97	5.55	3.87	8.09	3.90	6.96
N	27	28	21	20	48	48
Grade 2						
Mean	9.83	14.17	10.52	14.89	10.70	14.55
S.D.	4.28	6.02	5.62	6.44	4.97	6.19
N	29	24	29	27	58	51
Grade 3						
Mean	11.76	19.44	12.31	19.58	12.01	19.51
S.D.	6.58	7.49	6.69	7.08	6.57	7.23
N	29	27	26	24	55	51

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